IMPROVEMENT OF ELECTROCHEMICAL PERFORMANCE OF SOFC COMPOSITE ELECTRODE FORMED BY EPD

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It is well known that solid oxide fuel cells (SOFCs) are the next-gen hydrogen fueled power generator, because of their high energy conversion efficiency and fuel adjustability. In order to achieve high electrical performance of SOFC, the lowering of the overpotentials of both electrodes, cathode and anode, is indispensable as well as the lowering of ohmic resistance of electrolyte. Up to date, much effort has been paid for developing electrode material with low overpotential. For instance, perovskite-type oxide with high electronic and oxide-ionic conductivities [1] and Ni-YSZ cermet with highly active Ni catalyst [2] are commonly used as cathode and anode of SOFCs, respectively. We previously succeeded in forming double layer cathodes consisting of LSM-YSZ as the active layer and LSM ($La_{0.8}Sr_{0.2}MnO_3$) as the current collecting layer (LSM-YSZ/LSM) by electrophoretic deposition (EPD) technique [3]. In the present study, EPD method was applied to fabricate anode and cathode of SOFCs and the resulting cell was evaluated in SOFC performance.

The bilayer anode films consisting of 50wt%Ni-YSZ (50Ni-YSZ) and 70wt%Ni-YSZ (70Ni-YSZ) were formed using EPD technique. For the monolayer anode, the 70Ni-YSZ was superior to the 50Ni-YSZ in its anodic property. However, the formation of the 50Ni-YSZ/70Ni-YSZ bilayer gave a significantly higher anodic property compared to the monolayer anodes. This result suggests that the 50Ni-YSZ, which has a lower Ni content, possesses a greater number of reaction sites due to its higher Ni dispersion compared to the 70Ni-YSZ, and the addition of the 70Ni-YSZ layer effectively enhanced the anodic property. Since the 70Ni-YSZ layer has a porous structure, it functions as a good gas diffusion and current collecting layer. The critical thickness of the 50Ni-YSZ as an active layer was 3 □m in the present anode structure.

The bilayer cathode films, LSCF/YSZ, LSCF/GDC and LSCF-GDC/GDC (LSCF: $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$, GDC: $Gd_{0.1}Ce_{0.9}O_{1.95}$), were prepared by EPD. The bilayer cathodes exhibited significantly higher properties compared to the LSCF single layer cathode. The formation of the interlayer was effective to enhance the cathodic property. In spite of the formation of $SrZrO_3$ insulating phase, the LSCF/YSZ exhibited even higher property in its initial property than the LSCF/GDC. We tentatively assign this result that EPD formation of the LSCF/YSZ bilayer gives a thermally stable interface between LSCF and YSZ. However, upon long-term heating at 1100 ^oC for 100 h, the LSCF/YSZ bilayer significantly deactivated. On the other hand, the LSCF/GDC bilayer did not change in its property. The EPD technique using the mixed suspension of LSCF and GDC successfully gave LSCF-GDC composite cathode on the GDC interlayer. The LSCF-GDC/GDC bilayer cathode was superior to the LSCF/YSZ and the LSCF/GDC cathode in its initial property and long-term stability.

In conclusion, it was found that EPD technique significantly improved the interface between electrolyte and electrode (anode and cathode) of SOFC, resulting in the lowering of the electrode overpotential and the achievement of long-term stability.

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